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Worldwide Report

NUCLEAR DEVELOPMENT AND PROLIFERATION

(FOUO 13/81)

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CZECHOSLOVAKIA

HEALTH HAZARDS AT NUCLEAR POWER PLANT V-1 ASSESSED

Bratislava BRATISLAVSKE LEKARSKE LISTY in Slovak No 2, Aug 81 pp 231-240

[Article by Jozef Carach, Maria Petrasova, Tomas Trnovec and Dusan Ondris: "Medical Care Aspects of Nuclear Power Engineering in the SSR." Regional Hygiene Center in Bratislava, Director Docent F. Schulz, M.D.; the Center of Physiological Sciences of the Slovak Academy of Sciences; the Institute of Experimental Pharmacology in Bratislava, Director Docent L. Benes, R.N.D., Candidate of Sciences; and the EBO Factory Health Care Center in Jaslovske Bohunice, Head Physician M. Homola, M.D.]

[Text] As a developed socialist country, Czechoslovakia decided to cover further power demands by building nuclear power plants. According to the plan's expectations, nuclear power plants with a total power output of 8,000 MW will be put in operation before 1990. The first Czechoslovak nuclear power plant had an experimental character; it was operated from 1972 to 1977 and fulfilled its program.

The second Czechoslovak nuclear power plant, V-1, is of a different type, based on a different conception with many unique technological elements. Before the end of the century, only this type of nuclear power plant will be built in our country, and our first experience from the hygiene inspection in this facility can significantly influence the hygiene approach to further stages in nuclear power plant construction development.

General Principles and Provisions for Staff's Health Protection in the V-1 Power Plant

1. Division of Space According to the Extent of Ionizing Radiation Hazard

All technological systems and equipment containing radioactive media are enclosed in hermetically sealed and screened spaces, equipped with an independent ventilation system. A so-called monitored zone has been established, where only a certain number of employees is allowed to enter under precisely specified conditions. The monitored zone areas are divided into unattended, semiattended and attended areas. The unattended areas include hermetically sealed boxes (steam-generator boxes, the volume compensator box, the radioactive media treatment station boxes, the reactor shaft, the rooms with the filtering apparatus for the ventilation systems, etc.). These spaces are characterized by high levels of external gamma radiation and the presence of radioactive substances. The staff enters the semiattended areas only with special permission for a certain period of time and is monitored by the members of the dosimetric service (the reactor hall, the main circulation pumps and main closing fittings control rooms, the measurement and regulation rooms, etc.).

In the attended areas, the radiation hazard is very low during regular operation and the staff's movements within this zone are not limited by time (the reactor hall control room, attendance corridors, communication corridors, etc.).

2. Dosimetric Monitoring Systems

With respect to the importance of the harmful effects of ionizing radiation in the working environment, an extensive dosimetric system is regularly installed in nuclear power plant facilities. The system has been designed to measure the radiation characteristics of the working environment and technological media (air, water).

a) Biologic Dosimetry

Biologic dosimetry concerns the radiation factors in both the working and living environment, to which the staff and the nearby population are immediately exposed. On the other hand, technological dosimetry utilizes the monitoring of radiation factors for the control of the conditions of technological equipment.

The stationary part of the biologic dosimetric system processes information obtained through individual detectors placed in various spaces of the nuclear power plant monitored zone. The information is signalled by sound or light whenever the adjusted levels have been exceeded in the detector's vicinity and in the radiation control block monitoring room, where the information is recorded at the same time. The volume activities of gases and aerosols are measured in the working site atmosphere, along with the levels of the exposure gamma-radiation input. Dosimetric instruments serve for periodical operational control of the situation in radiation.

b) Technologic Dosimetry

Of the wide spectrum of various measurements, performed to obtain information concerning the present conditions of the reactor's technological equipment and primary circuit through monitoring the active products, measuring ^{132}I and ^{134}I activities continuously is most important; next comes exposure gamma-radiation input to the primary circuit piping, in active-water treatment stations and the like. The penetration of radioactivity into the secondary circuit is monitored by measuring the exposure input on the live-steam piping and the total beta activity of the steam-air mixture taken from the turbine nozzles.

Samples of the media from the primary circuit and other technological circuits are taken to determine the total beta activity in laboratories, the tritium activity, as well as the activity of individual fissile and corrosive products. Gamma spectrometry and liquid scintillation spectrometry are used methodically. Timely discovery of failures in technological equipment through monitoring the radioactivity of the media is also important from the point of view of radiation safety.

3. Radioactive Waste Monitoring

The radioactivity of waste products being let out through the ventilation chimney is measured with equipment which permits determining the total beta activity of rare gases, long-term aerosols and steams ^{131}I. The data obtained are transferred to the radiation control monitoring room. Tritium in waste products is measured in samples continuously taken through capturing air humidity on silica gel.

4. Personal Dosimetry

The staff dose exposure to external beta radiation and gamma radiation is measured with the method of film dosimetry, complemented by measurements using ionizing chambers and thermoluminescence method. The dose exposure to fast neutrons is measured with a trace dosimeter. Every member of the staff is equipped with a set of personal dosimeters corresponding to the radiation characteristics of the environment in which he works.

5. Monitoring the Surface Contamination of the Staff Members

Stationary dosimetric instruments have been installed at the exit from the monitored zone for measuring the surface contamination of the staff members' clothes and bodies. Portable dosimetric instruments serve in operative monitoring of the surface contamination of staff members as well as areas.

6. Monitoring Internal Contamination of the Staff Members

The Plant Health Center monitors internal contamination in the staff members. The staff members are examined according to their position and the type of work they perform. Selected professionals, such as shift dosimetrists, maintenance staff members, operators of the reactor's auxiliary systems, chemists manipulating with radioactive samples and the like, are examined routinely at 1 month periods.

Further, the staff members participating in work assignments involving increased hazard of internal contamination or those having been surface contaminated to a certain significant extent are examined regularly. In both cases, the basic examination consists of measuring the radioactivity with an entire-body computer, determination of the radioactivity of the thyroid gland, checking the internal contamination by tritium, and determining the total radioactivity from the beta-spectrometric and gamma-spectrometric examination of biological material.

Preventive medical examinations also include monitoring internal contamination. In this way, internal contamination is examined in every member of the staff subject to some exposure for at least 1 year. The extent of this examination depends on the frequency and type of work performed in the environment with ionizing radiation.

The dose exposure of the V-1 power plant staff members due to internal contamination ranges within very low levels. In several tens of cases, increased total beta activity, the presence of ^{134}Cs, ^{137}Cs and tritium have been found. Not even a single case of the occurrence of radioactive iodine has been discovered.

The dose exposure from internal contamination has never exceeded the value of 1 mSv.

Up-To-Date Hygiene Experience From the Operation

All physical parts of the nuclear power plant were put into operation according to a scientific program and instructions prepared in advance. The reactor reached the critical state on 27 November 1978. The process of activating the reactor for power generation at various output levels up to the nominal output was completed on 30 March 1979. Since then, the V-1 power plant has been in trial operation, during which the provisions for radiation protection incorporated in the design are being tested thoroughly, together with other characteristics.

1. Contamination of Technological Circuits

The radiation hazard in a nuclear power plant is related directly to the conditions of the reactor and its primary circuit, primarily to the inventory of fissile and corrosive products. Apart from nuclides with short half-life period of disintegration, such as ^{16}N, ^{42}K, ^{24}Na, whose specific radioactivity under the conditions of the reactor's nominal output ranges within the level of 10^6Bq.kg^{-1}, ^{131}I, ^{134}I, ^{91}Sr, ^{134}Ba and ^{144}Ce nuclides were also found in the cooling water of the primary circuit, their specific activity levels ranging between 10^2 - 10^4 Bq.kg^{-1}. From corrosive products, the presence of ^{56}Mn, ^{60}Co and ^{187}W has been ascertained. Their radioactivity does not exceed 1.85-10^5Bq.kg^{-1}. The volume activity level of ^3H in the primary circuit is maintained at 10^5Bq.l^{-1}, which is by one order less than the value prescribed in the design.

No significant leakage has been found in the technological equipment of the primary circuit and its auxiliary circuits, which might lead to significant contamination of the working areas of the power plant. No defects in the hermetic sealing of the fuel rod casing have been found, either.

2. External Radiation Hazard in the Power Plant Areas

The gamma-radiation dose input level in the attended areas (Table 1) keeps at tenths of Gy.h^{-1}, which is almost the level of a natural background. Exceptionally, increased values have been measured in the fittings attendance room where the box for the water intake from the primary circuit is situated.

In semiattended areas, higher levels of gamma radiation have been found, ranging between the levels of ones to tens Gy.h^{-1}. The inputs in the unattended areas are related to the types of technological equipment and the magnitude of the radioactivity present in this equipment. All these areas are closed to staff members during the reactor's operation.

3. Surface Contamination and Radioactive Aerosols in the Power Plant Areas

It follows from the measurements (Table 2) that surface contamination has been ascertained only exceptionally, namely in the areas of the water-treatment station of the primary circuit in the steam-generator and main circulation pumps measuring rooms and in the area where the radiation of the water from the primary circuit is monitored. The contamination had been caused by leakage through vents and seals, and having been discovered, it was stopped immediately.

The volume radioactivity of aerosols in both attended and unattended areas ranges about the level of ones to tens $mBq.l^{-1}$. Higher values have been found in the radiation monitoring room of the primary circuit water and in the rooms with steam-generator and main circulation pumps measuring instruments, as a result of surface contamination.

The volume of beta activity of rare radioactive gases ranges between ones and tens $Bg.l^{-1}$.

4. Radiation Exposure of Staff Members

The high technological standard of the primary circuit equipment is reflected in low dose exposure of personnel. Not even for a single month did a collective dose of external gamma radiation exceed 0.02 Sv; nearly 800 workers were examined (Table 3). No significant differences were found between the evaluations performed during the gradual process of activating the plant and those performed during trial operation with the nominal output. Analyzing the distribution of the collective doses to various groups of professionals we found out that beside the equipment attendance staff, also chemists, dosimetrists and leading technical personnel were exposed to doses during the process of physical and energetical activation of the plant, whereas the attendance and maintenance personnel almost exclusively participate in the dose exposure during trial operation.

5. Radioactive Wastes

The results of monitoring the radioactive wastes in the ventilation chimney (Table 4) testify of a good radiation situation during the operation of the first block of the V-1 power plant. The radioactivity of rare gases (radioisotopes of xenon and crypton) amounts to several percent, aerosol beta activity reaches only several hundredths of a percent and ^{131}I only several tenths of a percent of the permissible limits.

6. Liquid Radioactive Wastes

All waste water leaving the V-1 power plant is monitored dosimetrically. Year limits have been determined for the discharge of radioactive substances into the living environment, further specified for fissile and active corrosive products and tritium. The up-to-date monitor records show that the amount actually discharged reaches the permissible limits only partially. The average value of the total beta activity of the waste water discharged from the power plant in the first half of 1979 is 2.34 $Bq.l^{-1}$. The share of the content of ^{90}Sr and ^{137}Cs in the total beta activity is 70 percent. The radioactive substances discharged into the living environment cause to the population living in the plant's vicinity negligible dose exposure, if compared with the exposure to natural radioactive background.

Table 1

Levels of Gamma-Radiation Dose Inputs in the Monitored Zone ($\mu Gy/h$)

Areas	Measured Place	Reactor Output 8-35 % Nom.	50% Nom.	100% Nom.
Unattended	Steam-Generator Box, Water Treatment Station	6,000.0		
	Fittings Room	20.0		
	Exchangers Room	50-2,000		
	Filters Room	40.0		
Semi-Attended	Radiation Monitoring Room of the Water Treatment Station	0.7	1.5	1.0-2.0
	Main Circulation Pumps Platform	6.0-25.0	0.9-20.0	1.0-4.0
	Reactor Hall	0.1- 0.7	0.4- 4.0	1.0-4.0
Attended	Reactor Hall Control Room	0.1	0.1	0.1
	Ventilation System Attendance Corridor	0.1	0.2	0.1
	Fittings Attendance Room	0.8	0.2-0.3	0.2-1.0
	Primary Circuit Water Box	70.0	40.0	180.0
	Attendance Corridors	0.1	0.1	0.1

T a b l e 2

Levels of Surface Contamination and the Volume Radioactivity of Aerosols in the Monitored Zone

Areas	Measured Place	Surface Contamination in $mBq.cm^{2}$	Volume Radioactivity of Aerosols mBq. 1
Unattended	Steam-Generator Box, Water Treatment Station	10-20.0	10.0-20.0
	Fittings Room	10.0	
	Exchangers Room	10.0-15.0	
	Filters Room	40.0	
Semi-Attended	Radiation Monitoring Room of the Water Treatment Station	10.0-1,500.0	70.0
	Main Circulation Pumps Platform	10.0	29.0
	Reactor Hall	10.0	3.7-17.0
Attended	Reactor Hall Control Room	10.0	11.0 -12.6
	Ventilation System Attendance Corridor	10.0	13.9- 22.2
	Fittings Attendance Room	10.0-20.0	11.5- 23.7
	Attendance Corridors	10.0	13.0- 40.7
	Special Operation Building Hall	10.0	16.3

Table 3

Survey of the Dose Exposure of the Staff in the Period from the Reactor's Physical Start to November 11, 1979

Month and Year	Number of Workers Examined	Collective Dose mSv			Maximum Individual Dose mSv			Groups of Workers According to the Magnitude of γ Dose Received in mSv		
		γ	β	n	γ	β	n	up to 0.10	0.11-1.0	1.01-5.00
November 1978	770	3.9	0	0	0.7	0	0	760	9	1
December	791	18.2	1.7	0.7	2.2	0.9	0.7	768	17	6
January 1979	791	6.3	0	2.7	1.9	0	1.7	778	12	1
February	800	4.8	0	0	1.8	0	0	787	12	1
March	757	4.2	1.1	1.9	1.2	1.1	0.7	749	7	1
April	752	2.4	0	4.8	0.6	0	1.4	745	7	0
May	762	1.0	3.2	2.8	0.2	3.2	0.9	756	6	0
June	782	0.5	0	0	0.4	0	0	780	2	0
July	787	0.4	0	0	0.2	0	0	785	2	0
August	811	3.7	0	2.2	0.4	0	1.1	801	10	0
September	816	7.6	0	0.7	1.3	0	0.7	802	13	1
October	838	2.2	0.3	0	0.4	0.3	0	829	9	0
November	886	4.5	0	0	1.0	0	0	873	12	1

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Table 4

Radioactivity of Waste Products Discharged from the JE V-1 Power Plant in 1979

Month	Gases TBq	Percent from Limits	Aerosols MBq	Percent from Limits	^{131}I MBq	Percent from Limits
January	22.488	5.7	19.869	0.014	36.004	0.65
February	18.169	4.7	20.929	0.015	30.340	0.55
March	16.402	4.2	40.959	0.028	18.870	0.34
April	16.399	4.2	29.940	0.021	88.870	1.61
May	17.994	4.6	25.826	0.018	15.340	0.28
June	21.184	5.4	19.319	0.013	12.404	0.22
July	19.190	4.9	17.005	0.012	3.652	0.07
August	21.490	5.2	22.914	0.016	4.196	0.08
September	13.028	3.3	28.060	0.019	5.210	0.09
October	5.013	1.2	25.512	0.017	3.77	0.07
November	5.721	1.5	17.438	0.012	10.839	0.20
December	5.809	1.4	16.617	0.011	3.400	0.06

Discussion

Compared to other technologies, the pressure-water nuclear reactor technology is most widely used and evaluated as a whole from various aspects, including radiation exposure, it reaches the best parameters. The V-1 power plant is equipment manufactured in series. The favorable experience with the radiation situation in both working and living environment of a power plant of this type has been discussed in literature many times (Golubev and team, 1974; Martin, 1977; Murphy and team, 1977; Vohra, 1978; Voznesenskij, 1978).

Our present experience with the operation of the V-1 has been equally favorable. An overwhelming majority of nuclear power plants operating throughout the world at present are essentially of an analogous conception. We know from both our own and foreign experience that from the point of view of radiology, it is necessary to keep in mind two important factors.

1. The so-called human factor is accentuated as always more important. Despite advanced technological and engineering safety of the facility, mistakes in judgment, inadequate observation of operational regulations and duties can lead to serious failure with subsequent leakage of a significant amount of radioactive substances into the environment. Therefore, high professional standards, systematic supplementary training and testing the operational staff is emphasized. Technical tests aim at testing the knowledge of the physics of the reactor, technology and nuclear and radiation safety.

2. During operation some parts of the technological equipment wear out gradually, leakage occurs as a result of the damage of the compactness of the structural elements due to corrosion and the like. The ever-growing demands for maintenance and repair of the radioactive equipment result in the increase of individual exposures as well as the increase of the leakage of radioactive substances into the living environment.

At present, the need to obtain electric power, on the one hand, and the biologic zard resulting from this activity, on the other hand, are often discussed and considered. In our country, this question has been discussed in detail by Paulicka and Trnovec (1976); they pointed out that even in the case of optimal coverage of all of the Czechoslovak area with nuclear power plants, no inadequate biologic hazards threaten as a result of leakage from these facilities which might be reflected in the increase of lethal diseases or perhaps undesirable genetic consequences.

Summary

Factors of radiation hygiene in the operation of a nuclear power plant of a prospective type with a water-pressure reactor are surveyed. Both home and foreign experience shows that generating electric power using this type of nuclear technology is compatible with low biological hazard.

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NIGER

AUTHORIZATIONS FOR URANIUM EXPORTS DURING FIRST HALF 1981

Paris MARCHES TROPICAUX ET MEDITERRANNEENS in French No. 1869 4 Sep 81 p 2278

[Text] According to uranium export authorizations issued by decree published in the Official Gazette of the Niger Republic, the Niger government authorized exports of 4,846.9 tons of uranium during the first half of the year, to be delivered during 1981 to six countries: France, Libya, Japan, Spain, Federal Republic of Germany and Iraq.

France will be Niger's major customer, with authorized imports (decreed on 3 and 7 March) of 2,293.3 tons, as compared with 1,344.3 tons in 1980 and 100 tons in 1979. It is followed by Libya (1,212 tons in 1981, against only 380 tons in 1980), Japan (816 tons), Spain (300 tons), Federal Republic of Germany (with 125 tons of uranium for 1981, in comparison with 250 tons in 1980) and finally, for the first time, Iraq with 100 tons.

Out of these six customers, four, through subsidiaries, are shareholders in the capital of the two Niger uranium mining firms, SOMAIR (Air Mining Company) and COMINAK (Akouta Mining Company). Thus they have uranium export rights allocated on the basis of their share in the capital of the mining companies.

Niger, for its part, holds 33 percent of SOMAIR's capital and 31 percent of COMINAK's capital, through ONAREM (National Mineral Resources Board).

In SOMAIR, Niger's partners are France (General Nuclear Materials Company with 26.96 percent, French Uranium Company with 11.79 percent, Minatome with 7.58 percent and Mokta Mining Company with 7.58 percent), FRG (Urangesellschaft with 6.58 percent) and Italy (Agip Nucleare with 6.53 percent).

In COMINAK, ONAREM is joined by France (COGEMA with 34 percent), Japan (Overseas Uranium Resources Development with 25 percent) and Spain (Empresa Nacional de Uranio with 10 percent).

Consequently only two countries, Libya and Iraq, which have no shares in the capital stock of the two Nigerien uranium companies, were importers of Nigerien uranium in 1981, purchasing it from ONAREM.

In examining the data in the Official Gazette of the Republic of Niger, it is found that although it is the first time that Iraq has bought uranium from Niger (decree of 28 January 1981), 1979 (150 tons) and 1980 (180 tons, then 200 tons). Economic observers note, however, that it is the first time that this country, which has no processing plant, has purchased such a large amount of uranium (1,212 tons). (For possible uses of this uranium by Libya, see under "Libya".)

French imports (2,293.3 tons) also register a clear increase over 1979 (100 tons) and 1980 (1,344.3 tons). Out of these 2,293 tons, 600 will go to the Atomic Energy Commission, as a special purchase outside the quota.

Japanese and Spanish imports have remained at about the same level as in previous years, while the FRG has reduced its demand by half from 1980 (250 tons) to 1981 (125 tons).

According to the Official Gazette, exports authorized during the first 6 months of the year will be made "in the course of 1981." It is rather unlikely, observers note, that further export authorizations will be issued for this year, since the total tonnage already authorized during the first half of 1981 exceeds the domestic production capacity by about 500 tons.

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BRIEFS

URANIUM SALES POLICY--By publishing in the JOURNAL OFFICIEL of 27 August a list of all sales of uranium decided on during the first 6 months of 1981, the authorities confirmed their resolution to make commonplace trade in a highly strategic product. Deliveries to Libya increased six times (1,212 tons as compared with 200 in 1980) and an initial purchase by Iraq (100 tons) was recorded. Whereas these two countries have been blacklisted, in particular by the United States which, invoking nonproliferation, would like to prohibit the third world states from access to nuclear energy, even to the atom bomb. The position of President Seyni Kountche is clear: "We are selling to any customer who, while accepting our prices, satisfies the purchase conditions set by the international commission in Vienna." The loading of blue barrels full of ore is carried out in broad daylight at the airports of Niamey and Agadez or in the port of Cotonou (Benin). Moreover, the quantities which will be sold to each of the customers is known in advance, by decree. Thus for exports which will be delivered this year: France will purchase 2,293 tons (as compared with 1,344 in 1980 or 47 percent of total sales); Libya, 1,212 tons (25 percent); Japan, 816 tons (17 percent); Spain, 300 tons (6 percent); the FRG, 125 tons (3 percent) and Iraq 100 tons (2 percent). In total: 4,846 tons for 1980. In fact, to boycott some purchaser or other according to the whims of western diplomacy would be tantamount for the Nigerien Government to losing control of the receipts of foreign exchange vital for the pursuit of economic development [Text] [Paris JEUNE AFRIQUE in French No 1080, 16 Sep 81 p 31] [COPYRIGHT: Jeune Afrique GRUPJIA 1981]

JAPANESE URANIUM EXPLORATION AGREEMENT--A Japanese company, the Power Reactor and Nuclear Fuel Development Corporation [PNC], signed on 9 September in Niamey a draft agreement with the Nigerien Office of Mineral Resources [ONAREM] for the exploration and exploitation of a new uranium deposit. The ONAREM-PNC association is to start soon its exploration in Agadez Department (northern Sahara), on the In Adrar site. The draft agreement was signed for the Nigerien side by the minister of mines, Annou Mahamane, the director of ONAREM, Sani Koutoumbi, and by the director of the PNC, Mikio Isetani. It stipulates that the Japanese company will finance the exploration and installations at the rate of 400 million CFA francs for the next 2 years and an additional 600 million CFA francs for the fourth year. Japan is already active in Niger in the exploration and exploitation of uranium in particular through the Overseas Uranium Resources Development [OURD], which holds 25 percent of the capital of the Akouta Mining Company [COMINAK], one of the two large Nigerien uranium exploitation enterprises, with the Air Region Mining Company [SOMAIR]. Japan has purchased in Niger 816.6 tons of uranium since the beginning of the year. [Text] [Paris MARCHES TROPICAUX ET MEDITERRANEENS in French No 1871, 18 Sep 81 p 2383] [COPYRIGHT: Rene Moreux et Cie Paris 1981]

CSO: 4719/29

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